Paper ID: 61783
student

Key Technologies (7)
Key Technologies (2) (2)

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DESIGN OF THE DOCKING MECHANISM FOR NON-COOPERATIVE SATELLITES.

Abstract

The new era for space started with small satellite development as they have proved to be more efficient in providing service with minimal resources and cost, thus making space affordable for small companies. But small satellite missions face difficulties of low mission lifetime their inability to deorbit increases space junk; thus, they are not sustainable in the long run, especially for large constellations. SpaceX with star-link and future missions from amazon can make this situation even worse. The next decade will see the biggest boom ever in the small satellite industry, but there will be concern about creating more debris with much more potential to create accidents and dead satellites.

This problem can be solved with in-orbit servicing of small satellite constellations; a service spacecraft can be fabricated to increase lifetime or refuel satellites to deorbit after the mission. Many companies are working on this project, but this complex servicing station has a lot of bottlenecks, and one is the need for a docking mechanism that can dock with non-cooperative satellites under specified size and mass constraints.

Current docking mechanisms have problems like low margin of error for direct hard-docking systems as MIT's universal docking port, or increased complexity in Boeing's NDS mechanism for International Space Station, or the need for an active female port in target spacecraft for electromagnetic capture; these mechanisms and the associated problems are further explained in the literature survey.

This paper presents a new and novel docking mechanism for small satellites compact enough to fit in 1U space. The mechanical docking port uses an eddy current braking mechanism for relative momentum dumping to slow non-cooperative spacecraft before docking; it also consists of a phased docking mechanism for soft and hard docking to increase the error margin. Finally, a single servo actuated locking mechanism ensures reduced hardware complexity and 6DOF docking till relative angular velocity of 30 deg/sec. The Simscape model of the docking port assembly is created to test the working of the locking mechanism and to find a suitable actuator size for the desired performance.